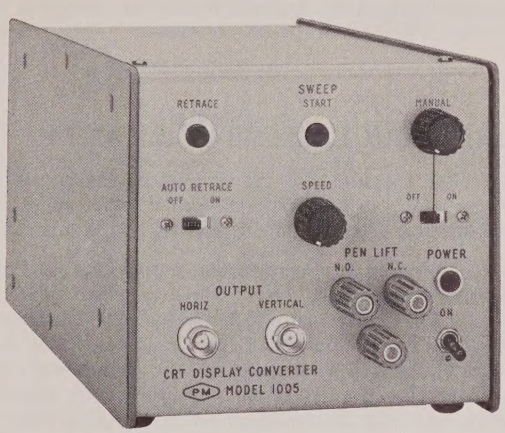
MODEL 1005

CRT DISPLAY CONVERTER

MODEL 1005

PM PACIFIC MEASUREMENTS INCORPORATED

INSTRUCTION MANUAL



CRT DISPLAY CONVERTER

MODEL 1005

SERIAL NUMBER _____

PM

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PACIFIC MEASUREMENTS INCORPORATED

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PACIFIC MEASUREMENTS INC. ("PM") certifies that this instrument was thoroughly tested and inspected and found to meet all its published specifications when it was shipped from the factory. PM further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

ONE YEAR LIMITED WARRANTY

PACIFIC MEASUREMENTS INC. ("PM") warrants to the original purchaser, and only the original purchaser, that this instrument will be free from defects in material and workmanship, under normal recommended use and operating conditions, for a period of one year after the date of delivery to the original purchaser.

PM's obligation under this Warranty is limited to (1) repairing or replacing, at PM's option, any part or parts (excluding RF diodes, RF connectors, batteries, and fuses) which are returned to PM in the manner specified below and which, upon inspection by PM's personnel, are determined to be defective as described above; and (2) calibrating the repaired instrument to current published specifications. If it is determined that the instrument is not defective, a nominal inspection charge will be charged and the instrument will be returned with transportation charges collect. If it is determined that the defect has been caused by misuse and/or abnormal operating conditions or that the instrument is not under Warranty, an estimate will be submitted prior to the commencement of necessary repair and calibration work. If the purchaser does not authorize PM to commence such repairs within fifteen days after such estimate is submitted, the instrument will be returned to the purchaser transportation charges collect.

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If any fault develops, the following steps should be taken:

a. Notify PM immediately, giving model number, serial or part number, code number, and a detailed description of the nature and/or conditions of failure. On receipt of this information, service, operating, or shipping instructions will be supplied to you.

b. On receipt of shipping instructions, ship the instrument transportation prepaid to PM. The instrument should be shipped in the original shipping carton or, if damaged or not available, in a suitable rigid container with the instrument wrapped in paper or plastic and surrounded with at least four inches or cushioning material on all sides. If under Warranty, the instrument will be repaired and returned transportation prepaid.

RECEIVING INSTRUCTIONS

The instrument must be thoroughly inspected immediately upon receipt. All material in the shipping container should be checked against the enclosed packing list. PM will not be responsible for shortages against the packing list unless notified immediately. Upon receipt of shipment, if there is any visible evidence of damages, make a notation on the way bill of such damage and immediately contact the nearest office of the carrier in your city. If there is evidence of damage after the goods are unpacked, contact the nearest office of the carrier, request an inspection, and save all packing and materials therein until the inspection has been completed. A full report of the damage should be obtained by the carrier's claim agent, and a copy of this report forwarded to PM. Upon receipt of this report, you will be advised of the disposition of the equipment for repair or replacement. PM shall have no responsibility for damaged instruments if the above inspection requirements are not complied with. Time is of the essence regarding the above instructions.

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SECTION 1
GENERAL INFORMATION

1.1 THE PACIFIC MEASUREMENTS MODEL 1005 CRT DISPLAY CONVERTER.

The Pacific Measurements Model 1005 CRT Display Converter is a complete instrument system which has at its input, voltages derived from the deflection electrodes of the cathode ray tube (CRT), and at its output a voltage identical in form to the input voltage but greatly lengthened in time scale. The time scale and magnitude of the output voltages are appropriate for use with X-Y or strip-chart moving pen recorders. Specifically, when used with a typical oscilloscope, the Model 1005 will have a sweep period adjustable from 15 to 180 seconds and output voltage levels of one volt per major division on the CRT graticule. Physically, the Model 1005 consists of an instrument module and the CRT adapter. The CRT adapter is a small circuit conveniently mounted close to the CRT deflection electrodes and provides at its output a replica of the CRT deflection voltages properly matched to the input characteristics of the instrument module. The CRT adapter is permanently installed in the oscilloscope and has a multi-pin connector into which any instrument module may be plugged. The instrument module has a mating multi-pin connector for connection into the adapter, a line connector for obtaining power and on its front panel, the operating controls and output terminals.

In operation the instrument module is connected to the CRT adapter, the X and Y input terminals of the recorder are connected to the horizontal and vertical output terminals of the Model 1005 and, if an electric pen-lift is provided on the recorder, the circuit may be connected to the appropriate pen-lift terminals on the Model 1005. The X and Y axis sensitivity of the recorder is adjusted to one volt per major division of the graph paper. The X position adjusted so that the pen is at the left edge of the paper, and the Y position set so that the pen is in a vertical position corresponding to the CRT beam position at the left edge of the display. To record the display, the pen is placed on the paper and the start button depressed. The recording may also be made manually thru use of the manual sweep control.

A variety of adapters is available so that the Model 1005 may be used with practically any electrostatic deflection type CRT; adapters for use with the more popular oscilloscopes will normally be available from the factory on a short delivery basis. The adapters are standardized so that they will work with any Model 1001 or 1005 instrument module. The Model 1005 may be used with virtually any X-Y or strip-chart recorder. Several excellent X-Y recorders particularly suitable for use with the Model 1005 are available at moderate cost.

1.2 MODEL 1005 PERFORMANCE SPECIFICATIONS.

Specifications of the Model 1005 CRT Display Converter are given in Table 1-1.

1.3 APPLICATIONS OF THE MODEL 1005 CRT DISPLAY CONVERTER.

The convenience with which a permanent record may be made of the CRT display makes it possible for the engineer to do a much more efficient and professional job of documenting his development and research work, and makes it easy for manufacturing personnel to obtain performance records of production items. Almost all oscillographic displays of a variable plotted against either time or another variable may be recorded. Detailed application information is given in Section 6.

TABLE 1-1 SPECIFICATIONS

Frequency Response:	DC to 60 MHz (for repetitive signals synchronized with oscilloscope sweep).
Minimum Oscilloscope Repetition Rate:	Once every 10 seconds.
Converter Scan:	Internal scan adjustable from 15 to 180 seconds. Manual scan controlled by front panel knob.
Recorder Drive Output:	
X-Axis (Horizontal):	1 ± 0.03 volts per major CRT graticule division, goes from 0 to +10 volts during each recording sweep.
Y-Axis (Vertical):	1 ± 0.03 volts per major CRT graticule division, 0 center with ± 5 volts maximum excursion.
Sweep Start:	Front panel push button initiates recording.
Sweep Retrace:	Automatic or manual, with front panel mode selector switch and push button.
Pen-Lift Output:	SPDT relay is energized during sweep, de-energized at end of sweep. Front panel banana jacks provided for normally open and normally closed contacts. Contact rating: 3 amps at 115 volts. (Can also be used for starting and stopping chart drive on strip-chart recorders.)
Power Requirement:	105 to 125 volts or 210 to 250 volts a-c, 50 - 400 Hz, 7.3 voltamperes.
Physical:	Modular style cabinet for bench or rack mounting.
Size:	4.97" H x 5.25" W x 10.50" D.
Weight:	Approximately 6 pounds. Shipping weight -10 pounds
Color:	Blue-gray with contrasting light panel.

SECTION 2
INITIAL INSTRUCTIONS

2.1 POWER REQUIREMENTS.

Units are ordinarily connected at the factory for operation from 105 volts to 125 volts ac, at 50 to 400 Hz. Units may be ordered for operation from 210 volts to 250 volts ac if so specified. Conversion from one voltage to the other may be readily made. See Figure 2-1. Reverse the Line Voltage Plate at the rear of the instrument to indicate the voltage for which the unit is wired.

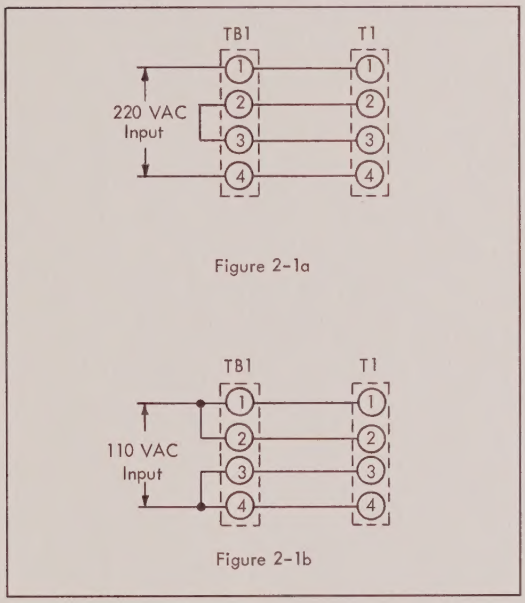


Figure 2-1a

Figure 2-1b

FIGURE 2-1

2.2 CHASSIS GROUNDING.

The instrument is supplied with a three-conductor NEMA type power cord. The instrument will be properly grounded if the plug is connected into a properly installed three-prong receptable. If a three-prong to two-prong adapter is used, be sure that the pigtail lead of the adapter is grounded.

WARNING

FAILURE TO PROPERLY GROUND THE INSTRUMENT CAN ALLOW DANGEROUS VOLTAGES TO BUILD UP ON THE CHASSIS WHICH COULD BECOME DANGEROUS TO OPERATING PERSONNEL.

2.3 ACCESSORIES.

The following accessories are provided with each Model 1005:

Qty.	Part No.	Description
1	10053	3 Conductor Power Cord
1	10068-1	Cable, BNC Male to Double Banana Plug (Vertical)
1	10068-2	Cable, BNC Male to Double Banana Plug (Horizontal
1	--	Instruction Manual
1	--	Adapter Kit (Part Number Depends upon the CRT Display Device with which the Model 1005 is to Operate)

SECTION 3
INSTALLATION INSTRUCTIONS

3.1 MECHANICAL INSTALLATION.

The mechanical installation of the CRT adapter will vary depending upon the instrument to which it will be attached. Several types of adapters are available from the factory for the most common types of oscilloscopes and CRT display devices. Specific mechanical installation instructions are packed in the container with the adapter.

3.2 ELECTRICAL CALIBRATION.

The Model 1005 CRT Display Converter is carefully calibrated at the factory. No further adjustments are required for this instrument to operate correctly and accurately. Since cathode ray tube sensitivities vary somewhat between units, it is necessary to perform a calibration on the adapter unit. This must be done carefully with precision equipment in order that the voltages from the adapter correspond correctly to those required by the converter module. Calibration instructions for the adapter are packed in the container with the adapter.

SECTION 4
PERFORMANCE CHECKS

4.1 RISE TIME.

Apply a 10 microsecond pulse to the oscilloscope and adjust the sweep speed such that the rise time of the pulse occupies at least one division of the oscilloscope graticule in the horizontal direction. Make a recording of this waveform with the Model 1005. The measured rise time should be within ± 3% + 3 nanoseconds of the rise time of the scope (for scopes with bandwidths up to 50 MHz).

4.2 MINIMUM REPETITION RATE.

Apply a 50 millisecond pulse with a repetition rate of between 1 and 10 pulses per second to the oscilloscope input. Adjust the scope for 10 milliseconds/division. Record the waveform. The record should be free of ripple.

4.3 CALIBRATION ACCURACY.

Apply a 100 microsecond pulse with a repetition rate of approximately 1 KHz to the oscilloscope input. Adjust the pattern on the scope for exactly 4 divisions of width and 4 divisions of vertical amplitude. Record the display. The recorded pulse should be 4 volts ± 3% vertical amplitude and 4 volts ± 3% horizontal width.

4.4 HORIZONTAL SWEEP TIME.

Rotate the sweep speed control all the way clockwise. The time required for one complete horizontal sweep should be less than 15 seconds. Now rotate the control all the way counterclockwise; the time for one sweep should be greater than 180 seconds.

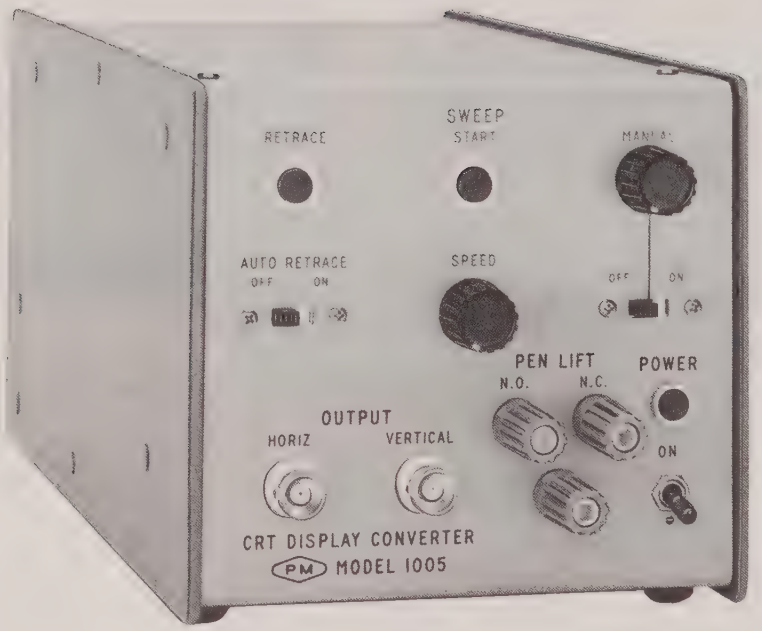

RETRACE
SWEEP
START
AUTO RETRACE
OFF ON
SPEED
OFF ON
PEN LIFT
N.O.
N.C.
POWER
OUTPUT
HORIZ
VERTICAL
ON
CRT DISPLAY CONVERTER
PM
MODEL 1005

FIGURE 5-1

SECTION 5
OPERATION

5.1 FRONT PANEL CONTROLS.

In addition to the power switch, there are six front panel controls. See Figure 5-1.

a. SWEEP START BUTTON. This button initiates the recording process.

b. SWEEP CONTROLS. Either manual or internal sweep may be selected with the MANUAL SWEEP ON or OFF switch. In the MANUAL SWEEP OFF mode, the horizontal voltage increases linearly with the time. The sweep speed may be adjusted from 15 to 180 seconds with the SWEEP SPEED knob so that recording time will be appropriate to the X-Y plotter used and signal repetition frequency. In the MANUAL SWEEP ON mode the sweep is controlled by the MANUAL SWEEP knob.

c. SWEEP RETRACE CONTROLS. Either manual or automatic retrace may be selected with the AUTO RETRACE ON or OFF switch. In the AUTO RETRACE OFF mode, the sweep starts when the start button is pressed and continues until one sweep is completed, then stops. Thus, the pen on the recorder moves from the left edge of the paper to the right edge of the paper and remains there until the RETRACE button is pressed. Whereupon, the sweep returns to the start position and the pen will rapidly move from the right edge of the paper to the left edge and stop. This mode is most useful with recorders that do not have an automatic pen-lift because it gives the operator an opportunity to manually lift the pen at the end of the recording.

   In the AUTO RETRACE ON mode, the recorder sweeps from left to right then automatically returns to the start position. This mode of operation is useful with recorders that have an automatic pen-lift.

5.2 FRONT PANEL CONNECTORS.

There are three front panel outputs on the Model 1005. One each for horizontal and vertical signals to the recorder and a third for the operation of the automatic pen-lift available in some X-Y plotters. See Figure 5-1.

a. HORIZONTAL OUTPUT. This BNC connector supplies a sweep voltage going from zero volts to + 10 volts to drive the X axis of X-Y recorders. The magnitude of this voltage is chosen to provide one volt per large graticule division in the X direction on a typical 10 division graticule used on most oscilloscopes.

b. VERTICAL OUTPUT. This BNC connector supplies a signal to the Y axis of the recorder. The magnitude of this signal is normally one volt per major oscilloscope graticule division in the vertical direction. There will be a one-to-one correspondence between the signal displayed on the oscilloscope and the graph made by the recorder if the recorder sensitivity is set at one volt per major division of the graph paper.

c. PEN-LIFT. Contacts are provided to actuate the pen-lift feature found on some X-Y plotters. Three connections are provided--a common terminal, C, a normally open contact, N.O., and a normally closed contact, N.C. "Normal," in this case, is defined as the time when the recorder is idle between periods of use. The contacts may be floated at potentials up to 500 volts above or below ground. Contact rating is 3 amperes at 115 volts a-c or 26 volts d-c for resistive loads. The pen-lift feature cannot be used in the MANUAL SWEEP ON mode.

5.3 OPERATING PROCEDURE.

a. Connect the line cord. Be sure that it is properly grounded.

b. Connect the signal input plug into the oscilloscope adapter jack.

c. Connect the HORIZONTAL OUTPUT of the Model 1005 to the X axis input connector of the X-Y recorder. (With strip-chart recorders, this output is not used.) Similarly, connect the VERTICAL OUTPUT of the Model 1005 to the Y axis input of the recorder.

d. Make appropriate connections to the PEN-LIFT output of the Model 1005 if this feature is applicable.

e. Turn POWER switch to ON. The "Power On" indicator light should glow immediately.

f. Check to see that the oscilloscope display to be recorded is triggered properly and that the trace is stable. If an X-Y recorder is used, adjust the X axis zero control so that the pen is on the left edge of the paper. Observe the vertical point at which the oscilloscope trace crosses the first vertical graticule line at the left edge of the oscillographic display. Adjust the Y axis zero control on the recorder so that the pen is in a corresponding position on the graph paper.

g. Select the proper retrace mode, AUTO RETRACE ON or OFF, as described in the section on front panel controls.

h. Press the START button. The recorder will automatically plot the cathode ray tube display on the graph paper.

SECTION 6
APPLICATION INFORMATION

6.1 GENERAL.

An oscilloscope is normally regarded as a high speed device for displaying rapidly varying electrical signals as a function of time; as such, it has found heavy application in electronics and other industries. Pacific Measurements CRT Display Converter opens up a new and useful area of application for the oscilloscope by making it possible to conveniently make a permanent record of the information displayed. A detailed list of specific applications for the CRT Display Converter follows:

a. Record Keeping for Later Reference.
There are numerous times when an engineer or technician needs to refer back to information obtained in an earlier stage of the project. Heretofore the engineer or technician normally has made notes of information, such as rise time, frequency response, or some other characteristic of the circuit that was considered important at the time the measurement was made. Now, keeping of complete records is made easy by the Pacific Measurements CRT Display Converter. A large, precisely scaled recording of the display on 8-1/2" x 11" graph paper can be made in a few seconds.

One of the problems of making notes is that it is not always known what information will be needed later on. If it is difficult to make a record, the information often goes unrecorded. Since it is now easy to make the record and to write on the recording other pertinent data obtained at the time the record is made, engineers may find it desirable to make more complete records in the anticipation of possible future requirements. The records, of course, may be reproduced on standard office copying equipment at any time.

b. Waveform Comparisons.
An ordinary oscilloscope with a Pacific Measurements CRT Display Converter and a recorder provides an excellent means for comparing waveforms and, in addition, produces a permanent record for later reference. A convenient procedure for making comparisons is to record the two waveforms to be compared on the same paper with the Y axis position of the recorder offset slightly. The two waveforms thus will lie almost but not exactly on top of each other and it is very easy to see any differences between the two. For more precise comparisons, waveforms may be recorded separately on translucent paper and a direct overlay will provide very accurate time and amplitude comparisons. This is a particularly valuable technique where slight differences between two waveforms are important. The overlay method of comparison is also of value in testing such things as filters where response curves showing tolerance limits can be quickly compared to the actual response curve.

c. Performance Verification.
It is not uncommon for a customer to require the producer of a device to provide him with a permanent record of performance characteristics. For example, the purchaser of an electrical filter network may require data indicating the pulse response performance. This data is very conveniently obtained with an oscilloscope and the Pacific Measurements CRT Display Converter. Necessary copies may be made by a secretary on ordinary office copying equipment for inclusion with invoices or other shipping information normally supplied to the customer. A copy may also be kept in the company's files for reference purposes. This type of data is useful for control of quality in that complete historical data is available for comparison and quality trends are easily identified.

6.2 TYPES OF DISPLAYS THAT MAY BE RECORDED.

The Pacific Measurements CRT Display Converter may be used to make recordings of several types of oscillographic displays. However, some of the applications may not be obvious at first glance. The following section may help to answer questions concerning some of the more common types of displays which can be recorded:

a. Standard Amplitude versus Time Displays.
This is perhaps the most common type of display seen on an oscilloscope. To record this type of display, the unit is merely connected and a record is made. The bandwidth of the converter is sufficient that it should produce a record as precise as the oscilloscope display within the limitations of the particular recorder with which it is used.

b. Dual Trace Presentations.
Dual trace time sharing displays may be conveniently recorded with the Pacific Measurements CRT Display Converter. To accomplish this, set the oscilloscope to display one of the dual traces and record it, then allow the recorder to retrace, set the oscilloscope to display the other trace, and record it. The two traces will then appear on a single sheet of graph paper in exactly the same relative position as on the oscilloscope tube in the dual trace mode.

c. Sine Wave Sweep Displays.
There are numerous applications where it is convenient to display the characteristics of a device versus voltage instead of time. A common application for this sort of display is the production testing of Zener or breakdown diodes where the reverse characteristics are displayed against voltage. The Pacific Measurements CRT Display Converter is quite capable of reproducing this sort of display since it is responsive only to X axis and Y axis voltage. The recording will have precisely the same form as the oscilloscope display.

d. Spectrum Analysis.
The Pacific Measurements CRT Display Converter may be used to provide a recording of a spectrum analyzer display. The operation is exactly the same as with an oscilloscope.

e. Sampling Oscilloscope Plug-in Units.
Most sampling oscilloscope units have outputs suitable for operating X-Y recorders. However, the oscilloscope sweep must be slowed down to the point where the recorder can follow (10 or 20 seconds per sweep). For normal observation

of the oscilloscope display, the sweep repetition rate is set well above the flicker frequency. With the Pacific Measurements CRT Display Converter it is not necessary to slow down the sweep. The display can be observed on the oscilloscope and recorded at the same time.

f. Oscillographic Swept Frequency Displays. Most sweep frequency signal sources provide a frequency output that varies linearly with time and/or a voltage output proportional to frequency. Some sources use a sine wave sweep. The CRT Display Converter is a particularly useful tool where it is desired to observe a sweep frequency display on an oscilloscope and at the same time record it. Some swept sources permit slowing down the sweep rate so that an X-Y recorder can follow it directly. However, the oscillographic display is no longer useful at this very slow sweep rate. With the Pacific Measurements CRT Display Converter an accurate reproduction of what is being observed on the oscilloscope can be obtained without changing the sweep rate. In addition, some manufacturers of special oscilloscopes for this purpose require moderately high sweep rates in order to make use of automatic d-c balance stabilizing circuits. The converter is especially useful with this type of instrument.

Some types of frequency sources cannot be swept slowly. For this type of unit the CRT Display Converter is required if it is desired to have an X-Y plot of the swept display. It is not important to the CRT Display Converter whether the sweep is sine wave or a linear sweep; the recorded display will be the same as the oscillographic display in either case.

6.3 NOISY SIGNALS - A SPECIAL CASE

The bandwidth of the CRT Display Converter is limited only by the oscilloscope for signals synchronized with the oscilloscope sweep. This is not the case for random signals (noise). The bandwidth for random signals will be essentially limited by the frequency response of the recorder; i.e., only a few cycles per second. Thus, if a signal has noise associated with it, the noise will be very greatly reduced in relation to the signal amplitude. This property may be used to good advantage when studying signals in the presence of noise, in fact, good recordings can be made from signals many times smaller than the noise voltage.

6.4 LIMITATIONS.

It is important to recognize that the sampling technique used in the Pacific Measurements CRT Display Converter requires that the original display repeat itself at least once every 10 seconds. If used to reproduce waveforms of slower repetition rate, errors will occur in the reproduction. If it is desired to use the CRT Display Converter with both beams of a dual beam oscilloscope, two adapters will be required since outputs from each set of deflection electrodes must be obtained.

SECTION 7

CIRCUIT DESCRIPTION

7.1 BLOCK DIAGRAM DESCRIPTION.

A block diagram of the display converter is shown in Figure 7-1a and 7-1b. A signal is obtained from the horizontal and vertical deflection electrodes in the oscilloscope and divided down through an R-C divider, the output of which supplies a line driver amplifier. The necessary output signals are connected through a plug-in cable to the instrument module. Within the instrument module a slow sweep with a period adjustable from 15 to 180 seconds is generated on command from the START button. This sweep provides an output to drive the X axis of the recorder and an output to be compared with the horizontal sweep signal from the oscilloscope in the coincidence circuit. The coincidence circuit developes a pulse each time the horizontal sweep signal from the oscilloscope has an amplitude equal to the signal from the slow sweep generator. The result is that the generated pulse "scans" the horizontal signal from the oscilloscope from left to right, in a period governed by the speed of the slow sweep. The trigger is supplied to a sampling gate pulse generator and a data hold circuit. The sampling gate pulse generator developes a very fast pulse with a short rise time to be applied to the sampling gate. The sampling gate samples and stores briefly the vertical voltage from the adapter at the time of each coincidence. The sampling gate feeds its voltage to the data hold circuit, also triggered by the coincidence circuit, which retains the voltage until the next sample is taken. The output from the data hold circuit goes to the isolation amplifier where it is amplified so that its amplitude is exactly one volt per vertical division on the oscilloscope screen. The output of the isolation amplifier is connected to a front panel BNC connector and is the vertical output of the unit.

7.2 DETAILED CIRCUIT DESCRIPTIONS.

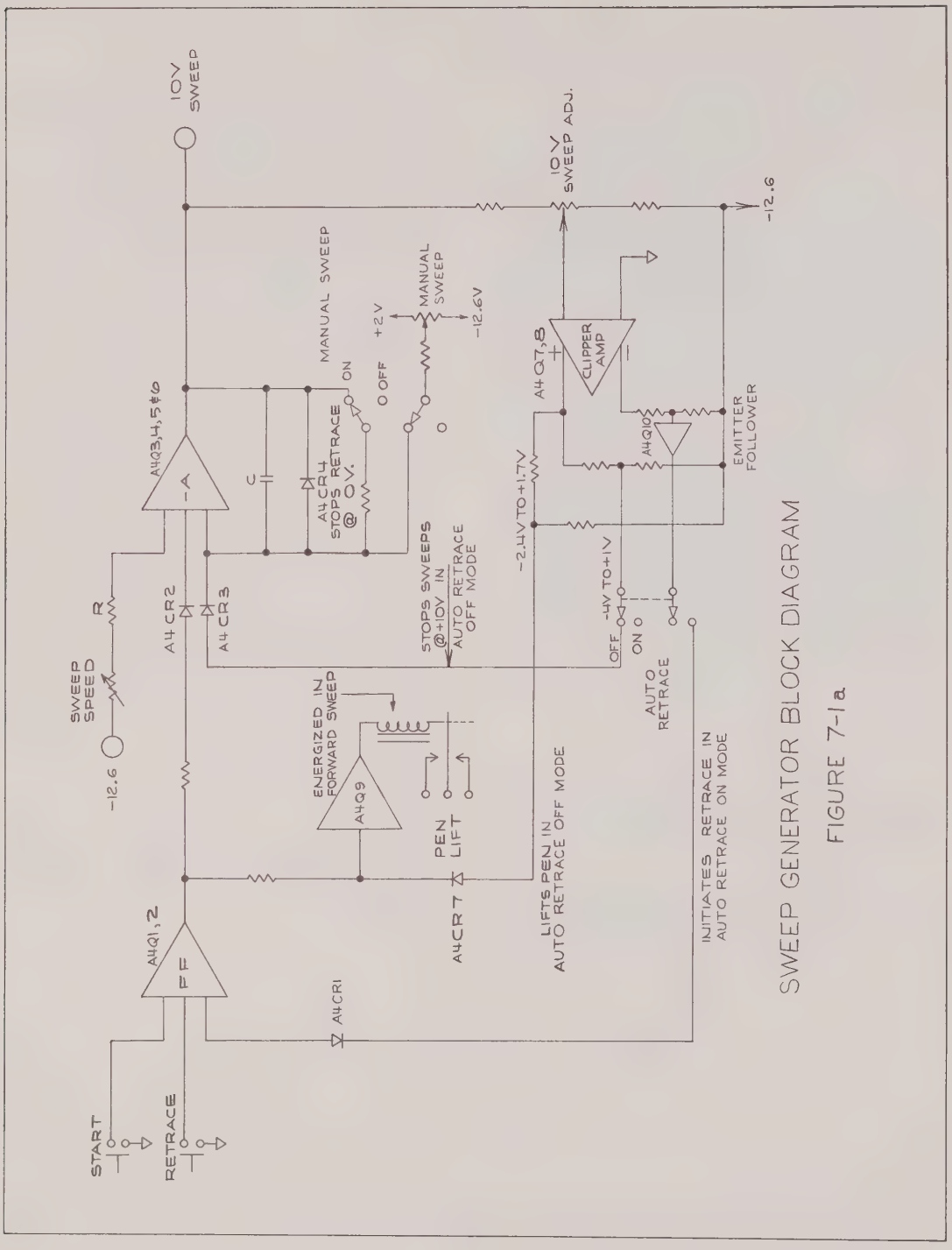
7.2.1 ADAPTER UNIT. A very high impedance R-C divider circuit drives an amplifier to develop the horizontal and vertical output signals. The vertical signal drives a terminated 50 Ohm transmission line, the horizontal signal drives an open circuited 75 Ohm transmission line.

7.2.2 INSTRUMENT MODULE. The slow sweep circuit contains a Miller integrator and a pair of flip-flop circuits. The first flip-flop is triggered by the START button and provides a constant voltage to the Miller integrator. The Miller integrator integrates this voltage to form the slow sweep. This ramp signal continues upward until the second flip-flop acting as a voltage comparator changes states and removes the voltage from the input of the Miller integrator. Depending on the position of the AUTO RETRACE switch, the sweep either returns to zero or holds at its end point value until the RETRACE button is depressed. Ancillary circuits provide power to operate the pen-lift relay and isolated output voltages to be supplied to the horizontal output terminal and to the coincidence circuit.

The coincidence circuit is a temperature compensated differential amplifier of very high gain. Its output triggers a highly regenerative pulse forming circuit which develops a very steep-fronted pulse with a rise time of approximately three nanoseconds. This pulse is differentiated by an R-C network and supplied through a pulse transformer to a pair of diodes which form the sampling gate. During the period when the sampling gate is open, the signal is connected to a small capacitor which stores the instantaneous signal voltage at the time the sampling gate is open. Since this capacitor has a very small value, it can store the voltage for only a few microseconds; consequently, a data hold circuit is required.

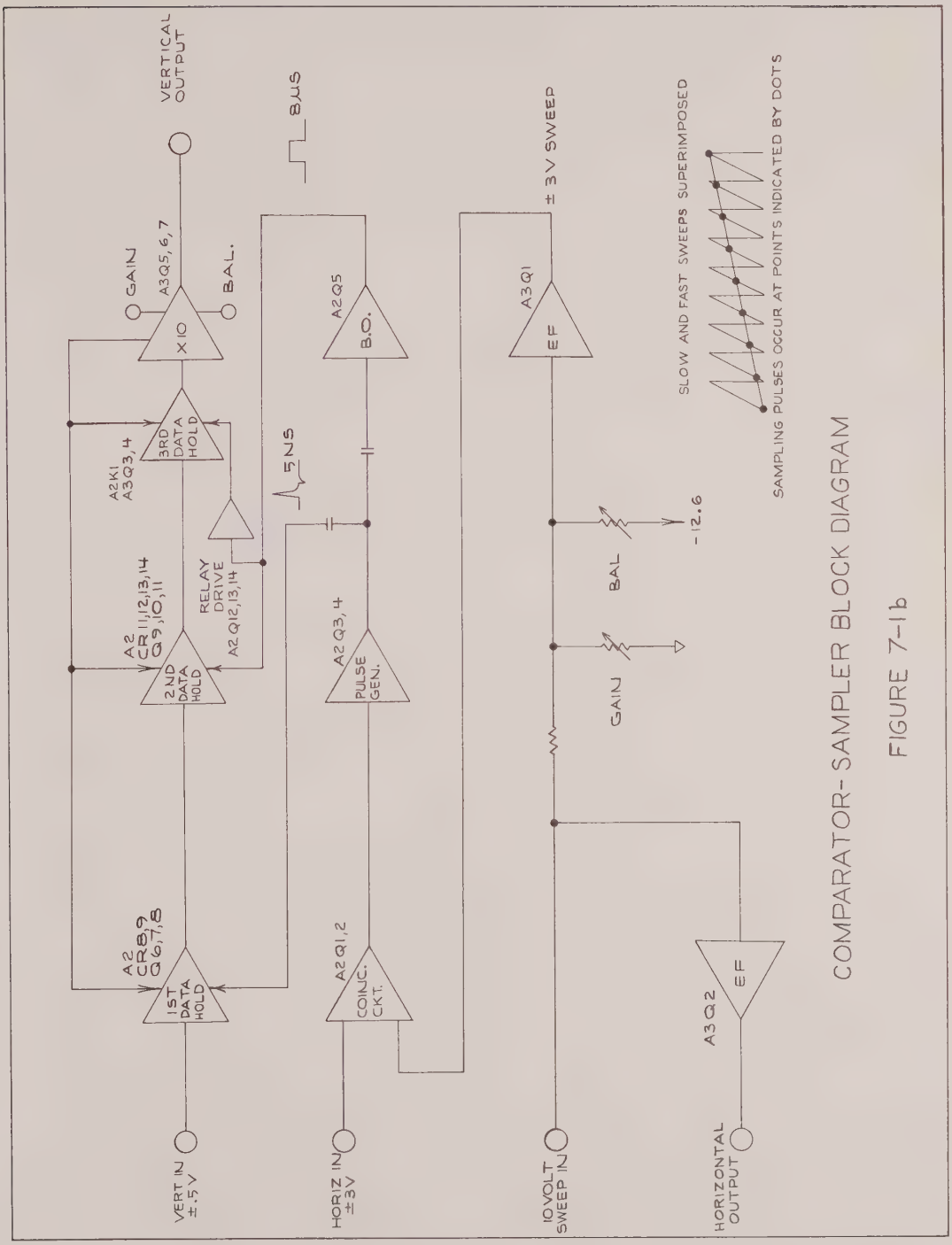
The data hold circuit is also triggered from the sampling gate pulse generator but unlike the sampling gate, it is driven from a pulse of some 8 microseconds duration. During this period, a grounded collector amplifier following the sampling gate storage capacitor charges a larger capacitor capable of holding the voltage period longer than the period between samples. An additional circuit is effective for repetition frequencies of less than about 100 Hz. A reed relay is used as the gate and is actuated for about 2 milliseconds, charging a still larger capacitor which can store the samples for many seconds. The data hold signal is supplied to a temperature compensated isolation amplifier with a gain of approximately ten. Thus, a signal of one volt per major graticule division on the oscilloscope is supplied to the X-Y recorder.

Power to operate the unit is supplied from the power line by means of temperature compensated, Zener regulated, precision power supplies. The two power supplies provide voltages of + and - 12.6 volts for use throughout the instrument and adapter unit.



SWEEP GENERATOR BLOCK DIAGRAM

FIGURE 7-1a



COMPARATOR-SAMPLER BLOCK DIAGRAM

FIGURE 7-1b

SECTION 8

MAINTENANCE

8.1 PERIODIC MAINTENANCE.

The following maintenance should be performed once a year unless the instrument is operated in an extremely dusty environment or is subject to severe abuse. In such cases more frequent maintenance is indicated.

a. Blow out all accumulated dust with forced air under moderate pressure.

b. Make a careful visual inspection of the unit looking for loose wires, broken connections, or damaged components. Check to see that all the PC boards are carefully seated in their connectors.

c. Make a performance check in accordance with the procedure of Section 4, "Performance Checks."

8.2 INTERNAL ADJUSTMENTS AND CALIBRATION.

Under normal conditions none of the internal adjustments should need adjusting except after a repair of a failure.

CAUTION

Do not attempt to make any adjustments on this instrument until you have read the following section completely. Some adjustments interact and must be made in the proper sequence or the instrument will not perform properly.

8.2.1 DESCRIPTION OF ADJUSTMENTS. The function of each adjustment is described below. Refer to Figure 8-1 for the location of each adjustment.

a. A1R18, -12.6 V POWER SUPPLY CALIBRATION ADJUSTMENT. Used to set the negative power supply to -12.6 volts ± 10 MV.

b. A1R9, +12.6 V POWER SUPPLY CALIBRATION ADJUSTMENT. Used to set the positive power supply to +12.6 volts ± 10 MV.

NOTE: The -12.6 volt power supply calibration must be set before the +12.6 volt power supply calibration is adjusted.

c. A4R21, 10 VOLT SWEEP CALIBRATION ADJUSTMENT. Used to set the horizontal output sweep amplitude to 10 volts peak to peak ± 50 MV.

d. A3R2, 6 VOLT SWEEP AMPLITUDE ADJUSTMENT. Used to set the amplitude of the internal sweep to 6 volts peak to peak. This adjustment interacts with A3R5.

e. A3R5, 6 VOLT SWEEP BALANCE ADJUSTMENT. Used to adjust the 6 volt sweep so it starts at -3 volts and ends at + 3 volts. This adjustment interacts with A3R2.

f. A3R26, VERTICAL OUTPUT BALANCE ADJUSTMENT. Used to set the vertical output to zero volts when there is zero volts at the vertical input.

g. A3R19, VERTICAL OUTPUT GAIN ADJUSTMENT. Used to set the vertical output so it changes one volt for each major division of the vertical deflection on the CRT.

h. A3R27, THIRD DATA HOLD BALANCE ADJUSTMENT. Used to compensate for variations in beta of A3Q3.

8.2.2 ADAPTER ADJUSTMENTS. The adapter unit adjustments are described in the Adapter Kit Instruction Manual.

8.2.3 CALIBRATION PROCEDURE. The following steps must be performed in the order indicated.

a. Check and adjust the power supply to conform to the voltages and tolerance given in 8.3a and 8.3c.

b. Adjust A4R21 to obtain 10 volts peak to peak ± 50 MV sweep at the horizontal output BNC.

NOTE: The 10 volt sweep does not start at precisely zero volts. Thus it is necessary to measure and record the voltage at the HORIZONTAL OUTPUT before starting the sweep. What is important is that the total voltage swing at the output terminal be exactly 10 volts and the sweep end point must be set accordingly. With the AUTO RETRACE switch set to OFF and the MANUAL SWEEP switch set to OFF, depress the SWEEP START button and allow one sweep to occur. After the sweep has stopped, adjust A4R21 so that the ending voltage minus the starting voltage is 10 volts ± 50 MV. Since the starting voltage may be either slightly positive or negative, it will be necessary to pay proper attention to the sign when performing the subtraction.

c. Connect a voltmeter to A3 TP7. Adjustment of A3R2 and A3R5 must be performed simultaneously as the two adjustments interact somewhat. With the AUTO RETRACE switch set to OFF and the MANUAL SWEEP switch set to OFF, allow the sweep to retrace and adjust A3R5 to obtain -3 volts. Press the START button and allow the sweep to complete its upward run, then adjust A3R2 to obtain +3 volts. Repeat this procedure until the sweep starts at -3.0 volts ± 20 MV and ends at +3.0 volts ± 20 MV.

d. The Model 1005 should now be connected into a properly installed and adjusted adapter unit on an oscilloscope. Set the oscilloscope sweep speed to .1 millisecond per division and the vertical sensitivity to minimum. Set the sweep mode to free run and center the trace vertically and horizontally on the CRT screen. Connect a voltmeter to TP8 on the scope adapter. Leave this meter connected during the following adjustments. Connect another voltmeter to the VERTICAL OUTPUT connector. Set the voltage at TP8 to zero volts by using the scope vertical position control. Adjust A3R26 for zero volts at the VERTICAL OUTPUT connector. Set the voltage at TP8 to +0.2 volts and adjust A3R19 for 2.0 volts at the VERTICAL OUTPUT connector.

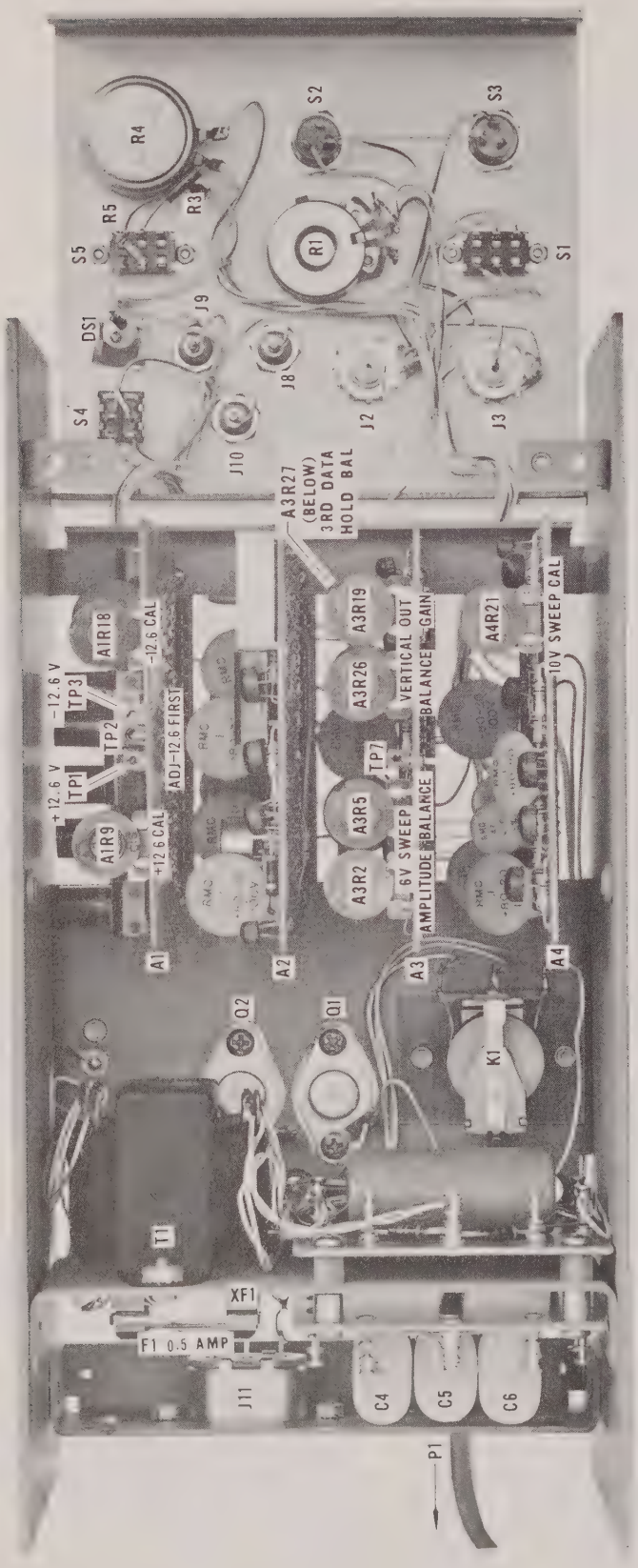

+12.6 V
-12.6 V
TP1
TP3
TP2
A1R18
-12.6 CAL
ADJ-12.6 FIRST
A1R9
+12.6 CAL
A1
A2
A3
A4
A3R27
(BELOW)
3RD DATA
HOLD BAL
A3R19
A3R26
VERTICAL OUT
BALANCE
GAIN
A4R21
10V SWEEP CAL
A3R2
A3R5
TP7
6V SWEEP
AMPLITUDE BALANCE
Q2
Q1
K1
T1
XF1
F1 0.5 AMP
J11
C4
C5
C6
P1
S4
DS1
S5
R5
R4
R3
J9
J10
J8
J2
J3
S2
S3
S1
R1

FIGURE 8-1

e. Without changing any connections, turn off the oscilloscope sweep and adjust A3R27 until the voltage of the VERTICAL OUTPUT connector does not drift more than 5 MV per second.

8.3 TEST POINTS.

a. TP1 +12.6 VOLTS. Measure between TP1 and ground (TP2).

+12.6 volts ± 10 MV. Ripple less than 0.5 MV peak to peak at 115 VAC line.

b. TP2 GROUND.

c. TP3 -12.6 VOLTS. Measure between TP3 and ground (TP2).

-12.6 volts ± 10 MV. Ripple less than 0.5 MV peak to peak at 115 VAC line.

d. TP4 AUXILIARY POWER SUPPLY. Measure between TP4 and +12.6 volts (TP1).

4.5 ± 1.0 volts, ripple less than 50 MV peak to peak at 115 VAC line.

e. TP5 PRIMARY REFERENCE VOLTAGE. Measure between TP5 and ground (TP2) 5.9 to 6.5 volts.

f. TP6 (A2Q8 Base) FIRST DATA HOLD OUTPUT. Measure between TP6 and ground using a 30 MHz scope. At the time the sampling gate is closed, the voltage should be 0.6 volts greater than the vertical input voltage at J5-13. This voltage should have a slow decay, 15 to 30 microseconds.

g. TP7 6 VOLT SWEEP. Measure between TP7 and ground (TP2).

- 3.0 volts ± 20 MV to +3.0 volts ± 20 MV.

h. TP8 VERTICAL OUTPUT PRE-AMPLIFIER. See Adapter Kit Instruction Manual.

i. TP9 HORIZONTAL OUTPUT PRE-AMPLIFIER. See Adapter Kit Instruction Manual.

j. TP10 (J5-3) HORIZONTAL INPUT. See Figure 8-2a.

k. TP11 (A2Q1 Collector) COMPARATOR OUTPUT. See Figure 8-2b.

l. TP12 (A2Q4 Emitter) PULSE GENERATOR OUTPUT. See Figure 8-2c.

m. TP13 (A2Q5 Emitter) BLOCKING OSCILLATOR CURRENT. See Figure 8-2d.

n. TP14 (A2Q14 Collector) A2K1 RELAY DRIVE. See Figure 8-2e.

8.4 TROUBLE SHOOTING.

CAUTION

Always turn the power off before removing or inserting an individual PC board. Be sure the PC board is inserted in the connector correctly as indicated in Figure 8-1. If the board is inserted backwards or into the wrong connector, serious damage may occur. If the board is operated on an extender, be particularly careful to see that the orientation of Figure 8-1 is observed. It is also important to handle printed circuit boards carefully during removal and insertion so as not to disturb the settings of the potentiometers which are on them.

8.4.1 LOCALIZATION OF TROUBLE. Use Trouble Shooting Table 8-1. Also make use of the test point information in Section 8.3.

After the trouble has been found and corrected, the calibration should be checked as outlined in Section 8.2.

8.4.2 LOCALIZATION OF TROUBLE TO INDIVIDUAL COMPONENTS. To determine whether a component is defective, it may be necessary to make active or passive circuit checks as well as waveform measurements. Where allowed by circuit voltages, the performance of a transistor that is forward biased can usually be determined by shorting the base to the emitter or by opening the base circuit. The transistor will be turned off in either case unless it is shorted. Performance may be determined by monitoring circuit parameters. A transistor can be assumed to be open if it does not conduct when its base-to-emitter voltage exceeds turn on.

Open or shorted transistors may also be located through resistance measurements across the elements. Exact values cannot be given due to the differences in transistors; however the ratio of forward and backward emitter-collector resistance is normally between 10:1 and 100:1. Higher power transistors have the lower ratios. If it is determined that a transistor is defective, look for other defective elements in the circuit that may have resulted from, or caused the transistor failure.

When checking resistors and capacitors, one lead should be disconnected to prevent shunt paths and possible damage to diodes and transistors.

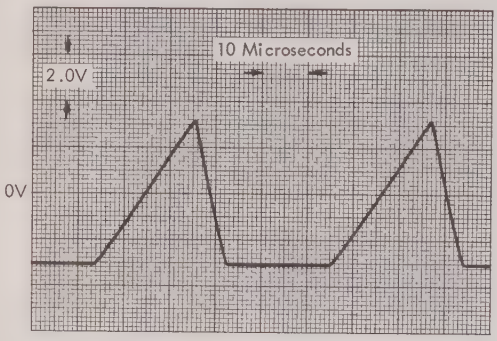
CAUTION

1. USE OF OHMMETER. Some ohmmeters may supply sufficient voltage or current to damage transistors. Before using an ohmmeter to check transistors or to make measurements in transistor circuits, be sure to check the voltage and current output of the ohmmeter on the range to be used. The open circuit voltage should not exceed 1.5 volts and the short circuit current should not exceed 3 mA or transistors may be damaged.

2. MEASURING TRANSISTOR VOLTAGES. Do not measure the base-to-emitter voltage of a transistor directly because auxiliary currents may damage the transistor. Measure the voltages independently with respect to ground.

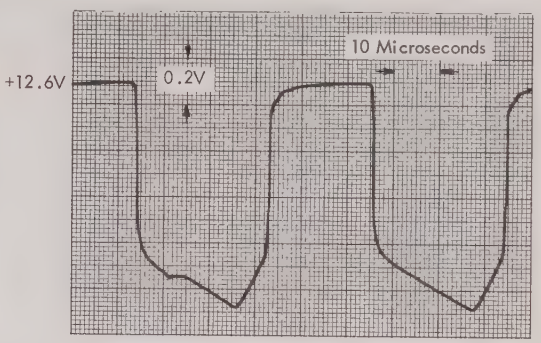
8.5 PARTS REPLACEMENT.

8.5.1 REPLACEMENT OF PARTS ON PRINTED CIRCUIT BOARDS. Before removing a component from a PC board, carefully note its orientation. Use a low wattage soldering iron (25 watts maximum) and apply heat sparingly to the component lead. Be sure that the soldering iron is grounded to prevent leakage current from damaging other components. The simplest way to remove a component with three or more leads is to cut the leads and then unsolder the remaining leads from the PC board. Clear the solder from the PC board holes with a toothpick or an awl for ease of insertion of the new component. To replace the component, form and cut the leads so that they extend approximately 1/16 inch through the PC board when the component is in position. Whenever possible hold the component lead with a tool that will act as a heat



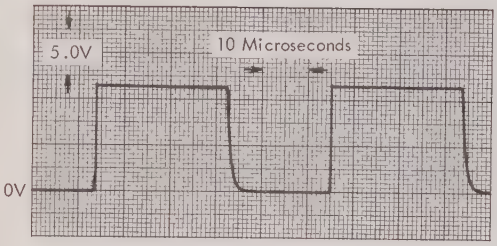
HORIZONTAL INPUT
J5-3
DC Coupled

Figure 8-2a



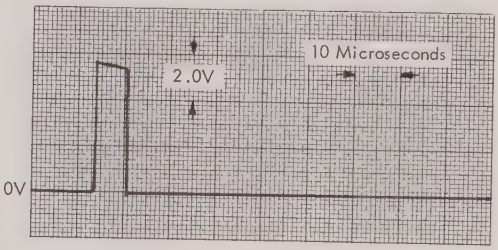
COMPARATOR OUTPUT
A2Q1 Collector
AC Coupled

Figure 8-2b



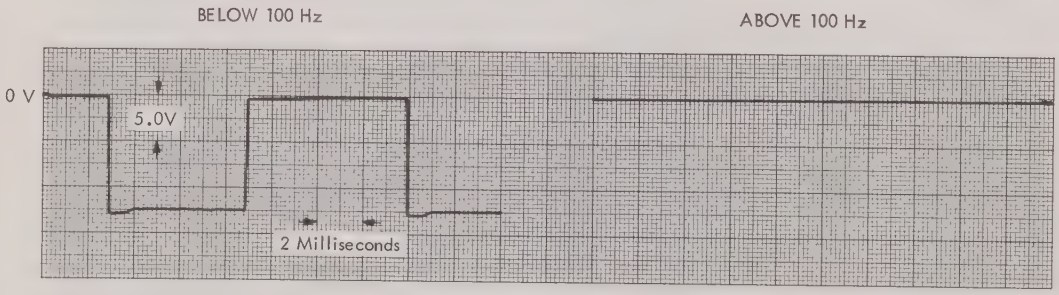
PULSE GENERATOR OUTPUT
A2Q4 Emitter
DC Coupled

Figure 8-2c



BLOCKING OSCILLATOR CURRENT
A2Q5 Emitter
DC Coupled

Figure 8-2d



A2K1 RELAY DRIVE
A2Q14 Collector
DC Coupled

Figure 8-2e

WAVEFORMS

FIGURE 8-2

sink and solder the lead from the opposite side. Avoid overheating and use a good quality rosin core solder. Cut off excess lead length and clean off any excess flux.

A break in the etched copper conductor may be repaired by soldering a piece of copper wire across the break. If the bond between the etched copper conductor and the base material fails, secure the conductor in place with a cement having good electrical insulating properties.

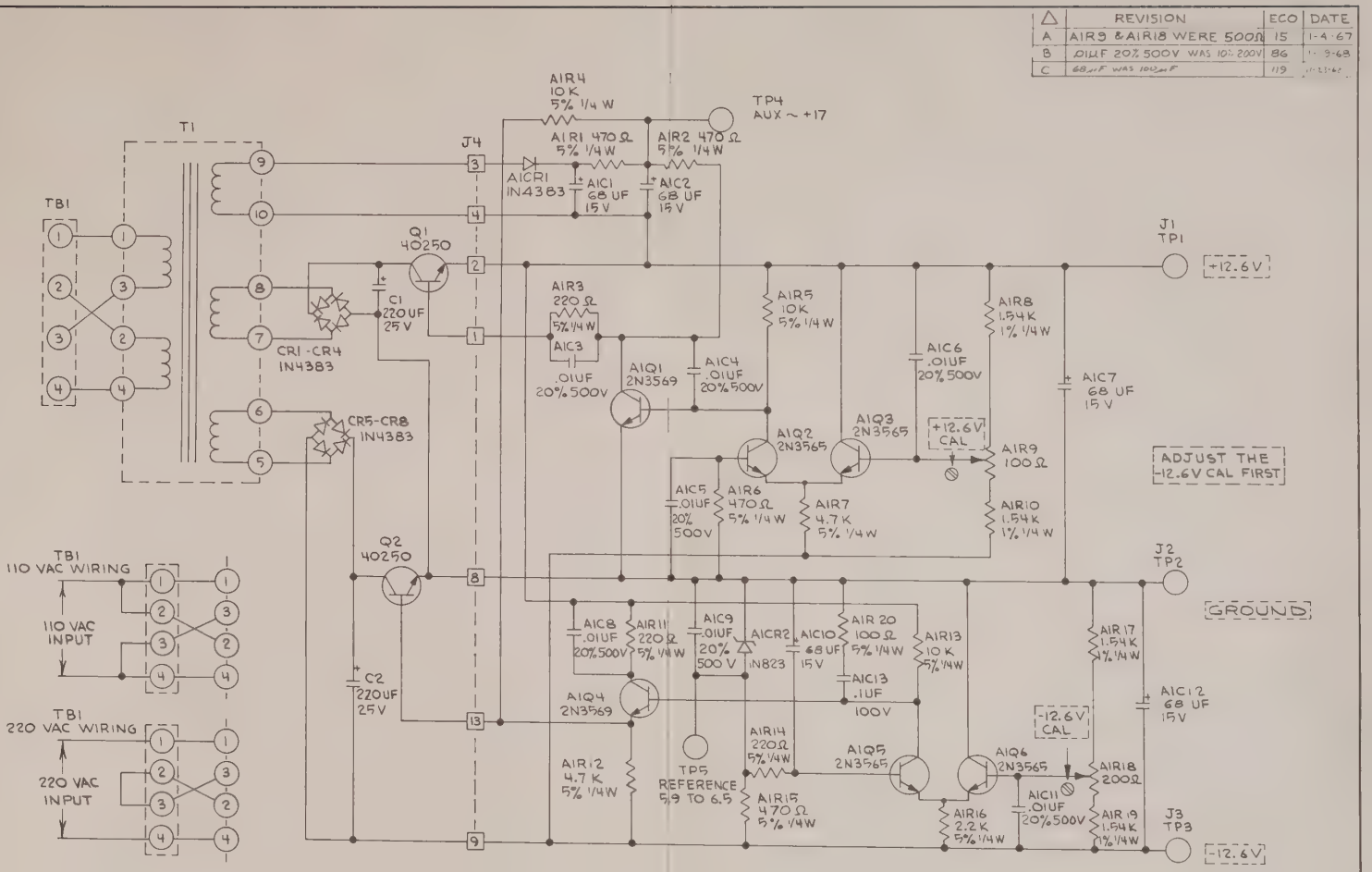
8.5.2 REPLACEMENT OF PARTS ON THE FRONT PANEL. Convenient access to the rear of the front panel has been provided. Remove the top cover, bottom cover and the two screws in the top edge of the front panel. The panel now may be rotated about a pivot at its lower edge.

TABLE 8-1 TROUBLE SHOOTING

INDICATION	CHECK
Pilot Light Out	1. Power Cord. 2. Fuse (F1); the fuse can be reached by removing the top cover. F1 is 0.5 amp. 250 volts. 3. Power Switch (S4). 4. Transformer (T1). The a-c output voltages from T1 are approximately: T1-5 to T1- 6 — 16 V Rms T1-7 to T1- 8 — 16 V Rms T1-9 to T1-10 — 6.3V Rms
No Horizontal Output	1. Power Supply Voltages +12.6 Volts -12.6 Volts If the voltages are close, this is not the trouble (within 0.1 volt), but after the trouble has been located and corrected, the supply voltages should be checked and if they are not within ± 10 MV of the specified value, they should be reset. 2. Sweep Start Push Button Switch (S2). NOTE: Try both auto retrace on and off modes of operation. 3. Sweep Generator Output (J7-3). If there is 10 volts peak to peak sweep at J7-3, check A3Q2. If there is no sweep voltage at J7-3, the trouble is located on PC board A4, the Sweep Speed potentiometer (R1) is open or (C4, C5, or C6) is defective.
No Vertical Output	1. Power Supply Voltages. NOTE: See Part 1 under "No Horizontal Output." 2. Vertical Input (J5-13). If no input voltage, check the scope and scope adapter. 3. Horizontal Input (J5-3). If no input sweep, check the scope and scope adapter. 4. 6 Volt Sweep Output (J6-6). If no output sweep, check the sweep generator output (J7-1). If there is 10 volts peak to peak sweep voltage, the trouble is probably A3Q1. 5. PC Board A2 and A3.
No Pen-Lift Output	1. Pen Lift Relay (K1). 2. A4Q9.

SECTION 9
SCHEMATIC DIAGRAMS

POWER SUPPLY	10187
COMPARATOR SAMPLER	10427
SWEEP GENERATOR AND SWEEP OUTPUT	10430
CHASSIS	10432



PACIFIC MEASUREMENTS

SCALE NONE	APPROVED BY	DRAWN BY B&A
DATE AUG 66		REVISED 1-4-67

SCHEMATIC POWER SUPPLY

DRAWING NUMBER 10187

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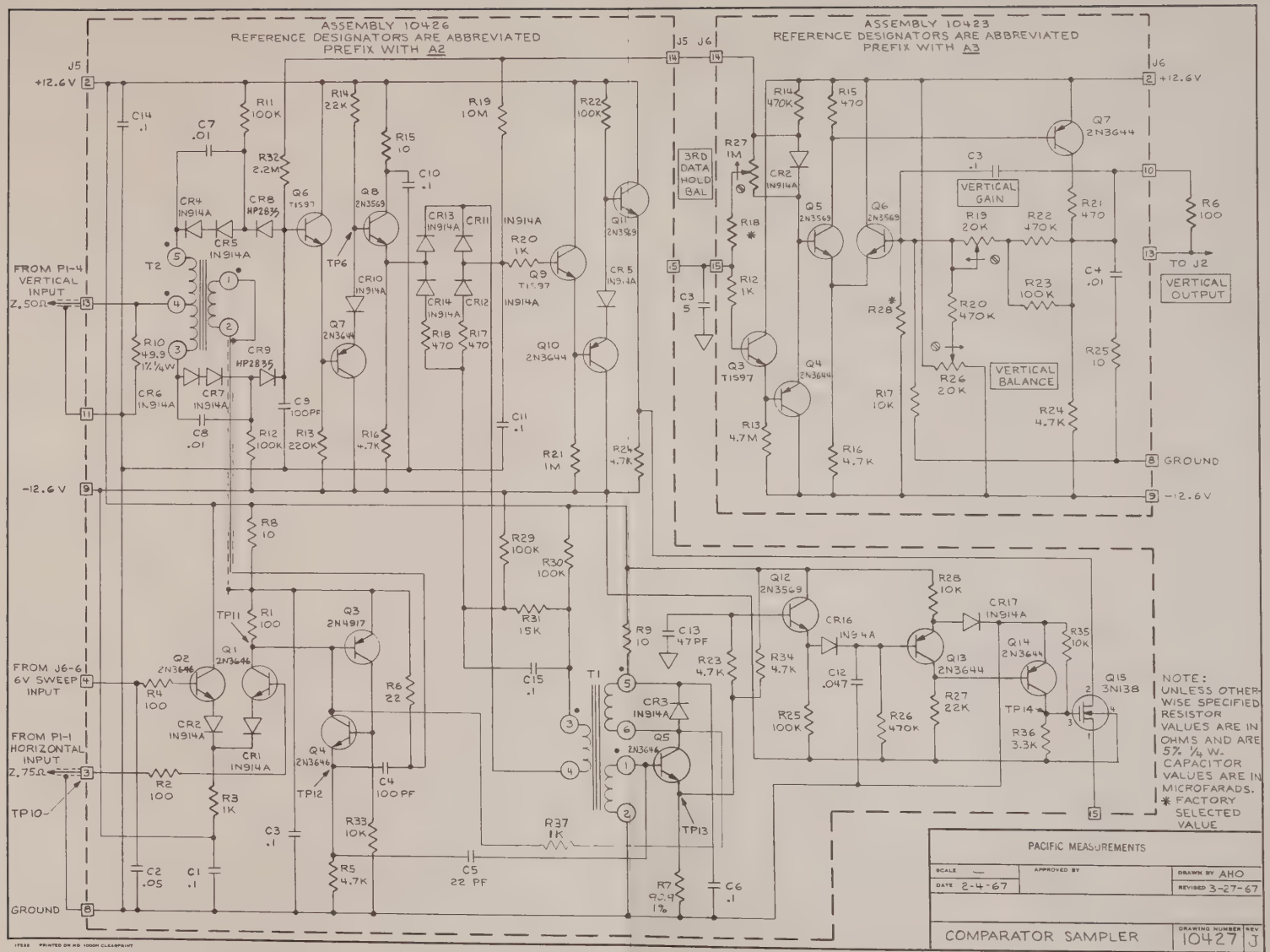
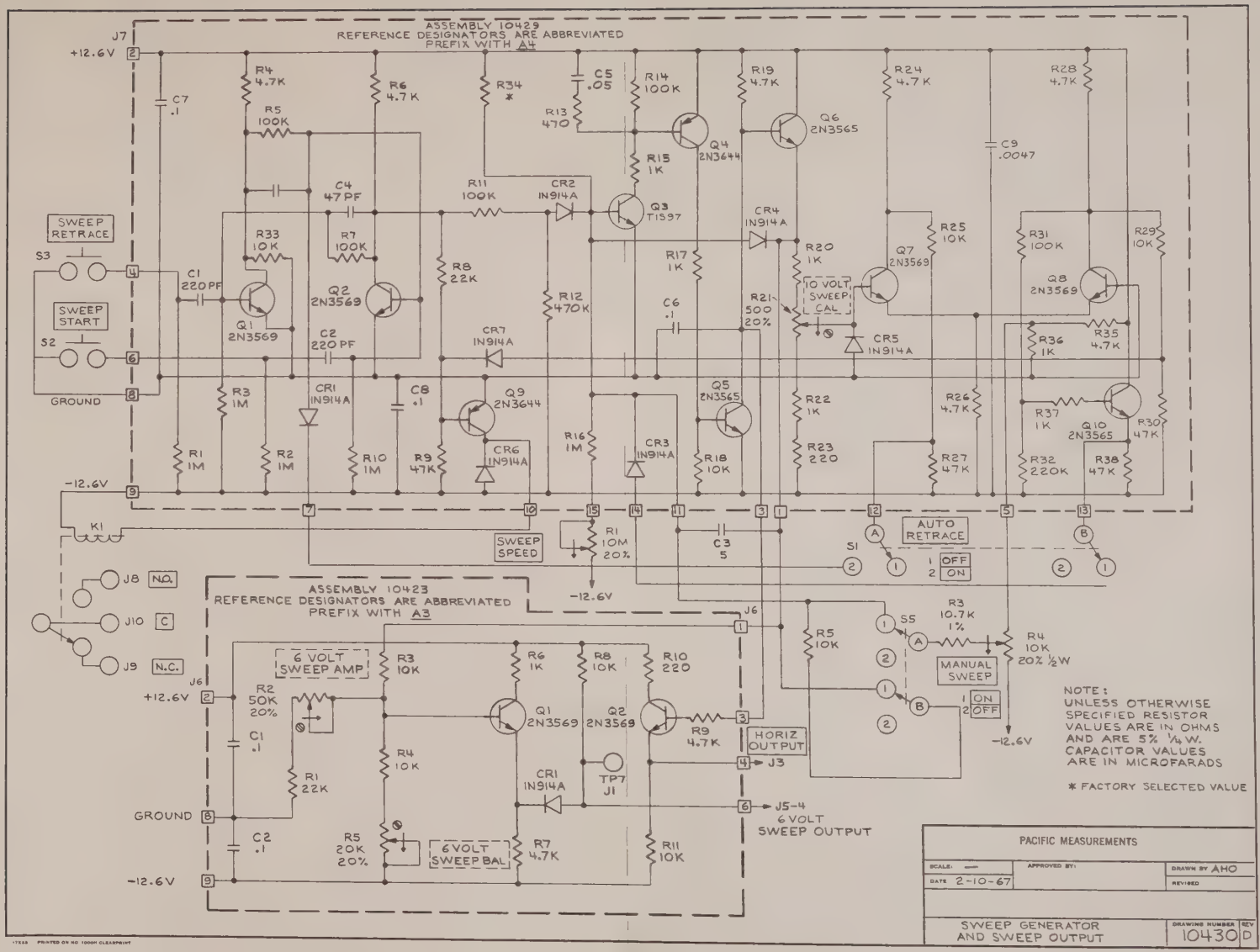
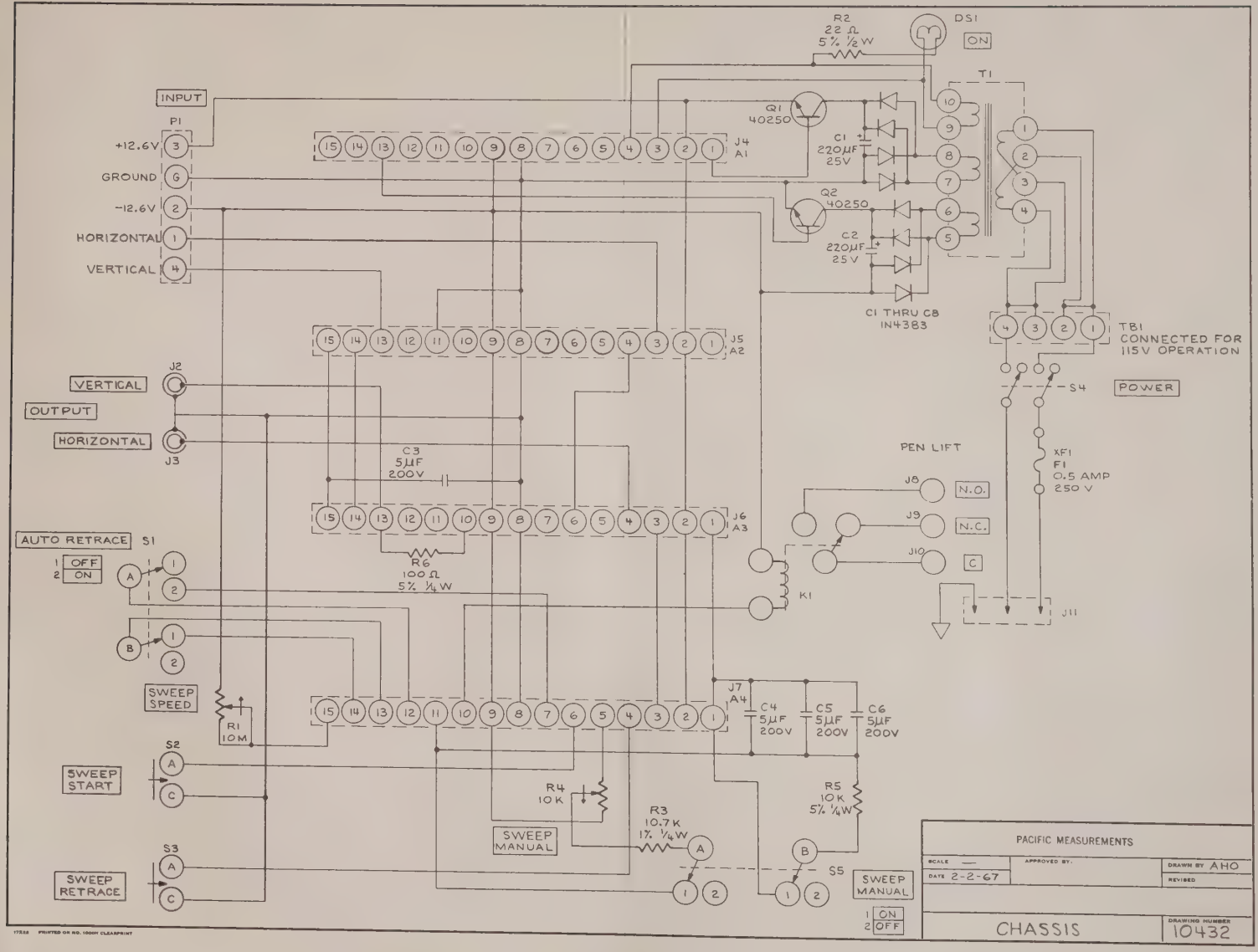

ASSEMBLY 10426
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A2
ASSEMBLY 10423
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A3
J5
J6
+12.6V
-12.6V
GROUND
FROM P1-4
VERTICAL
INPUT
Z, 50Ω
FROM J6-6
6V SWEEP
INPUT
FROM P1-1
HORIZONTAL
INPUT
Z, 75Ω
TP10
TO J2
VERTICAL
OUTPUT
3RD
DATA
HOLD
BAL
VERTICAL
GAIN
VERTICAL
BALANCE
NOTE:
UNLESS OTHERWISE SPECIFIED
RESISTOR
VALUES ARE IN
OHMS AND ARE
5% ¼ W.
CAPACITOR
VALUES ARE IN
MICROFARADS.
* FACTORY
SELECTED
VALUE
PACIFIC MEASUREMENTS
SCALE —
DATE 2-4-67
APPROVED BY
DRAWN BY AHO
REVISED 3-27-67
COMPARATOR SAMPLER
DRAWING NUMBER 10427
REV J


ASSEMBLY 10429
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A4
J7
+12.6V
C7 .1
R4 4.7K
R5 100K
R6 4.7K
R34 *
C5 .05
R13 470
R14 100K
Q4 2N3644
R15 1K
R19 4.7K
Q6 2N3565
R24 4.7K
R28 4.7K
C9 .0047
C4 47 PF
R11 100K
CR2 IN914A
Q3 T1597
CR4 IN914A
R17 1K
R20 1K
Q7 2N3569
R25 10K
R31 100K
R29 10K
SWEEP RETRACE
S3
SWEEP START
S2
GROUND
C1 220 PF
R33 10K
Q1 2N3569
R7 100K
Q2 2N3569
R8 22K
R12 470K
C2 220 PF
CR7 IN914A
C6 .1
R21 500 20%
10 VOLT SWEEP CAL
CR5 IN914A
Q8 2N3569
R36 1K
R35 4.7K
R3 1M
CR1 IN914A
C8 .1
Q9 2N3644
Q5 2N3565
R22 1K
R26 4.7K
R37 1K
Q10 2N3565
R30 47K
R1 1M
R2 1M
R10 1M
R9 47K
CR6 IN914A
R16 1M
CR3 IN914A
R18 10K
R23 220
R27 47K
R32 220K
R38 47K
-12.6V
K1
SWEEP SPEED
R1 10M 20%
C3 5
S1
AUTO RETRACE
OFF
ON
J8 N.O.
J10 C
J9 N.C.
ASSEMBLY 10423
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A3
J6
6 VOLT SWEEP AMP
R3 10K
R6 1K
R8 10K
R10 220
R2 50K 20%
Q1 2N3569
Q2 2N3569
R9 4.7K
HORIZ OUTPUT
J3
C1 .1
R4 10K
TP7 J1
R1 22K
CR1 IN914A
J5-4
6 VOLT SWEEP OUTPUT
C2 .1
R5 20K 20%
6 VOLT SWEEP BAL
R7 4.7K
R11 10K
R5 10K
S5
R3 10.7K 1%
R4 10K 20% ½W
MANUAL SWEEP
ON
OFF
NOTE:
UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS AND ARE 5% ¼ W. CAPACITOR VALUES ARE IN MICROFARADS
* FACTORY SELECTED VALUE
PACIFIC MEASUREMENTS
SCALE:
APPROVED BY:
DRAWN BY AHO
DATE 2-10-67
REVISED
SWEEP GENERATOR AND SWEEP OUTPUT
DRAWING NUMBER 10430
REV D



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SECTION 10
REPLACEABLE PARTS LIST

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
		CHASSIS - 10431
C1	10003-6	Electrolytic 220 µf +100-10% 35 WVDC
C2	10003-6	Electrolytic 220 µf +100-10% 35 WVDC
C3	10011-1	Mylar 5 µf ± 10% 200 VDC
C4	10011-1	Mylar 5 µf ± 10% 200 VDC
C5	10011-1	Mylar 5 µf ± 10% 200 VDC
C6	10011-1	Mylar 5 µf ± 10% 200 VDC
CR1	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
CR2	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
CR3	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
CR4	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
CR5	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
CR6	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
CR7	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
CR8	10044-1	Silicon (1N4383) 200 PRV 1 Amp ARC
DS1	10060-1	Pilot Light Assembly (Bulb Included) 7 Volts
F1	10064-2	AGC (3 AG) 1/2 Amp 250 Volts
J1		Not Used
J2	10048	BNC UG 1094/U
J3	10048	BNC UG 1094/U
J4	10050-1	Connector PC 15 Contacts
J5	10050-1	Connector PC 15 Contacts
J6	10050-1	Connector PC 15 Contacts
J7	10050-1	Connector PC 15 Contacts
J8	10056-3	Binding Post, Insulated Blue
J9	10056-3	Binding Post, Insulated Blue
J10	10056-3	Binding Post, Insulated Blue
J11	10052	3 Pin AC Receptacle
K1	10908	Relay, Sensitive SPDT 12 VDC 1350 Ω Coil
P1	10071	4 Conductor & Ground Audio
Q1	10020	Silicon (40250) NPN Power
Q2	10020	Silicon (40250) NPN Power
R1	10095-1	Panel Mount Slotted Shaft 10 Meg ± 20% CCWA Taper
R2	10241-2	Carbon Composition 22 Ω 5% 1/2 W
R3	10015-22	Metal Film 10.7 KΩ 1% 1/4 W
R4	10095-4	Panel Mount Slotted Shaft 10 KΩ ± 20% Linear Taper
R5	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
R6	10013-13	Carbon Film 100 Ω ± 5% 1/4 W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
S1	10059	Slide DPDT
S2	10058	Push Button SPDT
S3	10058	Push Button SPDT
S4	10057	Toggle DPDT
S5	10059	Slide DPDT
T1	10067	Transformer Power
XF1	10065	Block Fuse
		POWER SUPPLY PC BOARD ASSEMBLY - 10121
A1C1	10787-4	Electrolytic PC Mounting 68 µF 15 WVDC
A1C2	10787-4	Electrolytic PC Mounting 68 µF 15 WVDC
A1C3	10000-7	Ceramic .01 µF ± 20% 500 VDC
A1C4	10000-7	Ceramic .01 µF ± 20% 500 VDC
A1C5	10000-7	Ceramic .01 µF ± 20% 500 VDC
A1C6	10000-7	Ceramic .01 µF ± 20% 500 VDC
A1C7	10787-4	Electrolytic PC Mounting 68 µF 15 WVDC
A1C8	10000-7	Ceramic .01 µF ± 20% 500 VDC
A1C9	10000-7	Ceramic .01 µF ± 20% 500 VDC
A1C10	10787-4	Electrolytic PC Mounting 68 µF 15 WVDC
A1C11	10000-7	Ceramic .01 µF ± 20% 500 VDC
A1C12	10787-4	Electrolytic PC Mounting 68 µF 15 WVDC
A1C13	10000-10	Ceramic 0.1 µF +80 -20% 100 VDC
A1CR1	10044-1	Silicon Rectifier 1N4383 200 PRV 1 Amp ARC
A1CR2	10045	Zener Reference 1N823 6.2V ± 10%
A1J1	10054-2	Test PC Mounting Red
A1J2	10054-1	Test PC Mounting Black
A1J3	10054-3	Test PC Mounting Blue
A1Q1	10017	Silicon 2N3569 NPN
A1Q2	10019	Silicon 2N3565 NPN
A1Q3	10019	Silicon 2N3565 NPN
A1Q4	10017	Silicon 2N3569 NPN
A1Q5	10019	Silicon 2N3565 NPN
A1Q6	10019	Silicon 2N3565 NPN
A1R1	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A1R2	10013-21	Carbon Film 470 Ω ± 5% 1/4 W

CIRCUIT REFERENCE	HP PART NO.	DESCRIPTION
A1R3	10013-17	Carbon Film 220 Ω ± 5% 1/4 W
A1R4	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A1R5	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A1R6	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A1R7	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A1R8	10015-1	Metal Film 1.54 KΩ ± 1% 1/4 W
A1R9	10046-9	Variable Composition PC Mounting 100 Ω ± 20% Linear .2 W
A1R10	10015-1	Metal Film p.54 KΩ ± 1% 1/4 W
A1R11	10013-17	Carbon Film 220 Ω ± 5% 1/4 W
A1R12	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A1R13	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A1R14	10013-17	Carbon Film 220 Ω ± 5% 1/4 W
A1R15	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A1R16	10013-29	Carbon Film 2.2 KΩ ± 5% 1/4 W
A1R17	10015-1	Metal Film 1.54 KΩ ± 1% 1/4 W
A1R18	10046-6	Variable Composition PC Mounting 200 Ω ± 20% Linear .2 W
A1R19	10015-1	Metal Film 1.54 KΩ ± 1% 1/4 W
A1R20	10013-13	Carbon Film 100 Ohm ± 5% 1/4 W

COMPARATOR SAMPLER
PC BOARD ASSEMBLY - 10426

A2C1	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A2C2	10000-9	Ceramic General Purpose .05 µf +80-20% 500 VDC
A2C3	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A2C4	10001-7	Ceramic Temp. Comp. 100 pf ± 5% 1000 VDC NPO
A2C5	10001-4	Ceramic Temp. Comp. 22 pf ± 5% 1000 VDC NPO
A2C6	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A2C7	10000-7	Ceramic General Purpose .01 µf ± 20% 500 VDC
A2C8	10000-7	Ceramic General Purpose .01 µf ± 20% 500 VDC
A2C9	10001-7	Ceramic Temp. Comp. 100 pf ± 5% 1000 VDC NPO
A2C10	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A2C11	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A2C12	10007-6	Mylar .047 µf 10% 200 V
A2C13	10001-6	Ceramic Temp. Comp. 47 pf ± 5% 1000 VDC NPO
A2C14	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A2C15	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A2CR1	10043	Silicon High Speed (1N914A)
A2CR2	10043	Silicon High Speed (1N914A)
A2CR3	10043	Silicon High Speed (1N914A)
A2CR4	10043	Silicon High Speed (1N914A)
A2CR5	10043	Silicon High Speed (1N914A)
A2CR6	10043	Silicon High Speed (1N914A)
A2CR7	10043	Silicon High Speed (1N914A)
A2CR8	10815	Silicon Ultra High Speed (HP2835)
A2CR9	10815	Silicon Ultra High Speed (HP2835)
A2CR10	10043	Silicon High Speed (1N914A)
A2CR11	10043	Silicon High Speed (1N914A)
A2CR12	10043	Silicon High Speed (1N914A)
A2CR13	10043	Silicon High Speed (1N914A)
A2CR14	10043	Silicon High Speed (1N914A)
A2CR15	10043	Silicon High Speed (1N914A)
A2CR16	10043	Silicon High Speed (1N914A)
A2CR17	10043	Silicon High Speed (1N914A)
A2Q1	10018	Silicon High Speed (2N3646)
A2Q2	10018	Silicon High Speed (2N3646)
A2Q3	10398	Silicon High Speed (2N4917) or (2N4122)
A2Q4	10018	Silicon High Speed (2N3646) NPN
A2Q5	10018	Silicon High Speed (2N3646) NPN
A2Q6	11507	Silicon Low-Power NPN (TIS 97)
A2Q7	10023	Silicon High Current (2N3644) PNP
A2Q8	10017	Silicon General Purpose (2N3569) NPN
A2Q9	11507	Silicon Low-Power NPN (TIS 97)
A2Q10	10023	Silicon High Current (2N3644) PNP
A2Q11	10017	Silicon General Purpose (2N3569) NPN
A2Q12	10017	Silicon General Purpose (2N3569) NPN
A2Q13	10023	Silicon High Current (2N3644) PNP
A2Q14	10023	Silicon High Current (2N3644) PNP
A2Q15	10896	MOS FET (3N138)
A2R1	10013-13	Carbon Film 100 Ω ± 5% 1/4 W
A2R2	10013-13	Carbon Film 100 Ω ± 5% 1/4 W
A2R3	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A2R4	10013-13	Carbon Film 100 Ω ± 5% 1/4 W
A2R5	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A2R6	10013-5	Carbon Film 22 Ω ± 5% 1/4 W
A2R7	10015-53	Metal Film 90.9 Ω ± 1% 1/4 W
A2R8	10013-1	Carbon Film 10 Ω ± 5% 1/4 W
A2R9	10013-1	Carbon Film 10 Ω ± 5% 1/4 W
A2R10	10015-3	Metal Film 49.9 Ω ± 1% 1/4 W
A2R11	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A2R12	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A2R13	10013-53	Carbon Film 220 KΩ ± 5% 1/4 W
A2R14	10013-41	Carbon Film 22 KΩ ± 5% 1/4 W
A2R15	10013-1	Carbon Film 10 Ω ± 5% 1/4 W
A2R16	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A2R17	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A2R18	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A2R19	10013-73	Carbon Film 10 MΩ ± 5% 1/4 W
A2R20	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A2R21	10013-61	Carbon Film 1 MΩ ± 5% 1/4 W
A2R22	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A2R23	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A2R24	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A2R25	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A2R26	10013-57	Carbon Film 470 KΩ ± 5% 1/4 W
A2R27	10013-41	Carbon Film 22 KΩ ± 5% 1/4 W
A2R28	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A2R29	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A2R30	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A2R31	10013-39	Carbon Film 15 KΩ ± 5% 1/4 W
A2R32	10013-65	Carbon Film 2.2 MΩ ± 5% 1/4 W
A2R33	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W

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CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2R34	10013-33	Carbon Film 4.7 kΩ ± 5% 1/4 W
A2R35	10013-37	Carbon Film 10KΩ ±5% 1/4 W
A2R36	10013-31	Carbon Film 3.3KΩ ±5% 1/4 W
A2R37	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2T1	10443	Transformer, Pulse
A2T2	10144	Transformer, Pulse
		SWEEP OUTPUT - VERTICAL OUTPUT PC BOARD ASSEMBLY - 10423
A3C1	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A3C2	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A3C3	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A3C4	10000-7	Ceramic General Purpose .01 µf ± 20% 500 VDC
A3CR1	10043	Silicon High Speed (1N914A)
A3CR2	10043	Silicon High Speed (1N914A)
A3J1	10054-2	Test PC Mounting Red
A3Q1	10017	Silicon General Purpose (2N3569) NPN
A3Q2	10017	Silicon General Purpose (2N3569) NPN
A3Q3	11507	Silicon Low Power NPN (TIS 97)
A3Q4	10023	Silicon High Current (2N3644) PNP
A3Q5	10017	Silicon General Purpose (2N3569) NPN
A3Q6	10017	Silicon General Purpose (2N3569) NPN
A3Q7	10023	Silicon High Current (2N3644) PNP
A3R1	10013-41	Carbon Film 22 KΩ ± 5% 1/4 W
A3R2	10046-3	Variable Composition 50 KΩ ± 20% 1/4 W
A3R3	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A3R4	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A3R5	10046-2	Variable Composition 20 KΩ ± 20% 1/4 W
A3R6	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A3R7	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A3R8	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A3R9	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A3R10	10013-17	Carbon Film 220 Ω ± 5% 1/4 W
A3R11	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A3R12	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A3R13	10013-69	Carbon Film 4.7 MΩ ± 5% 1/4 W
A3R14	10013-57	Carbon Film 470 KΩ ± 5% 1/4 W
A3R15	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A3R16	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A3R17	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A3R18	---	Factory Selected Value
A3R19	10046-2	Variable Composition 20 KΩ ± 20% 1/4 W
A3R20	10013-57	Carbon Film 470 KΩ ± 5% 1/4 W
A3R21	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A3R22	10013-57	Carbon Film 470 KΩ ± 5% 1/4 W
A3R23	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A3R24	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A3R25	10013-1	Carbon Film 10 Ω ± 5% 1/4 W
A3R26	10046-2	Variable Composition 20 KΩ ± 20% 1/4 W
A3R27	10046-13	Variable Composition 1 MΩ ± 20% 1/4 W
A3R28	---	Factory Selected Value
		SWEEP GENERATOR PC BOARD ASSEMBLY - 10429
A4C1	10000-2	Ceramic General Purpose 220 pf ± 20% 1000 VDC
A4C2	10000-2	Ceramic General Purpose 220 pf ± 20% 1000 VDC
A4C3	10001-6	Ceramic Temp. Comp. 47 pf ± 5% 1000 VDC NPO
A4C4	10001-6	Ceramic Temp. Comp. 47 pf ± 5% 1000 VDC NPO
A4C5	10000-9	Ceramic General Purpose .05 µf ± 80-20% 500 VDC
A4C6	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A4C7	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A4C8	10000-10	Ceramic General Purpose 0.1 µf +80-20% 100 VDC
A4C9	10000-6	Ceramic General Purpose .0047 µf ±20% 500 V
A4CR1	10043	Silicon High Speed (1N914A)
A4CR2	10043	Silicon High Speed (1N914A)
A4CR3	10043	Silicon High Speed (1N914A)
A4CR4	10043	Silicon High Speed (1N914A)
A4CR5	10043	Silicon High Speed (1N914A)
A4CR6	10043	Silicon High Speed (1N914A)
A4CR7	10043	Silicon High Speed (1N914A)
A4Q1	10017	Silicon NPN General Purpose (2N3569)
A4Q2	10017	Silicon NPN General Purpose (2N3569)
A4Q3	11507	Silicon NPN General Purpose (TIS97)
A4Q4	10023	Silicon PNP High Current Switch (2N3644)
A4Q5	10019	Silicon NPN General Purpose (2N3565)
A4Q6	10019	Silicon NPN General Purpose (2N3565)
A4Q7	10017	Silicon NPN General Purpose (2N3569)
A4Q8	10017	Silicon NPN General Purpose (2N3569)
A4Q9	10023	Silicon PNP High Current Switch (2N3644)
A4Q10	10019	Silicon NPN High Gain (2N3565)
A4R1	10013-61	Carbon Film 1 MΩ ± 5% 1/4 W
A4R2	10013-61	Carbon Film 1 MΩ ± 5% 1/4 W
A4R3	10013-61	Carbon Film 1 MΩ ± 5% 1/4 W
A4R4	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A4R5	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A4R6	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A4R7	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A4R8	10013-41	Carbon Film 22 KΩ ± 5% 1/4 W
A4R9	10013-45	Carbon Film 47 KΩ ± 5% 1/4 W
A4R10	10013-61	Carbon Film 1 MΩ ± 5% 1/4 W
A4R11	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A4R12	10013-57	Carbon Film 470 KΩ ± 5% 1/4 W
A4R13	10013-21	Carbon Film 470 Ω ± 5% 1/4 W
A4R14	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A4R15	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A4R16	10013-61	Carbon Film 1 MΩ ± 5% 1/4 W
A4R17	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A4R18	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A4R19	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A4R20	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A4R21	10046-1	Variable Composition 500 Ω ± 20% Linear 0.2 W
A4R22	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A4R23	10013-17	Carbon Film 220 Ω ± 5% 1/4 W
A4R24	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A4R25	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A4R26	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A4R27	10013-45	Carbon Film 47 KΩ ± 5% 1/4 W
A4R28	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A4R29	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A4R30	10013-45	Carbon Film 47 KΩ ± 5% 1/4 W
A4R31	10013-49	Carbon Film 100 KΩ ± 5% 1/4 W
A4R32	10013-53	Carbon Film 220 KΩ ± 5% 1/4 W
A4R33	10013-37	Carbon Film 10 KΩ ± 5% 1/4 W
A4R34	10142-1	Carbon Composition 18 MΩ ± 5% 1/4 W
A4R35	10013-33	Carbon Film 4.7 KΩ ± 5% 1/4 W
A4R36	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A4R37	10013-25	Carbon Film 1 KΩ ± 5% 1/4 W
A4R38	10013-45	Carbon Film 47 KΩ ± 5% 1/4 W

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